Human Interface to Netcentricity

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Abstract

Successful net-centric operations in theatre have stimulated interest in the application of net-centricity to the Department's support organizations.

In this paper we draw parallels between the warfighter's limited achievement of decision superiority and self-synchronization, and our business community's need for decision superiority and self-organization; net-centricity expanded tooth to tail.

We recognize however, that the movement towards an expanded net-centric environment has implications to the Department's overall organizational culture and patterns of interaction. The development of a complex information infrastructure without adequate focus on both cultural and socio-technical issues will likely result in significantly lower return on our investment.

Of concern are a number of key areas including ad-hoc COI formation, the usability of interface designs, and the impact of culture on measuring progress towards a net-centric environment. More importantly, we conclude that ubiquitous information sharing is not likely to be achieved without a transformation to a trusting, transparent culture. This paper examines these issues and based on recent research results, provides suggestions for future direction.

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Overview

In a recent interview concerning intelligence sharing, Marine Corps General James Cartwright, Commander USSTRATCOM, stated that the greatest obstacle is not technology but culture – "It's not a technical issue any more," he said. "It's really more about culture and the need to share rather than the need to know." A critical aspect of the net-centric environment involves the human interface component. This article examines the several aspects of the human interface to net-centricity, both in connection to the various options for communication and in support of an expansion of net-centric concepts to encompass the entire tooth-to-tail support processes.

The impetus for this examination was drawn from a three-year pilot project involving ten acquisition programs that experimented with approaches and methodologies to dramatically speed up the acquisition process. During the synthesis phase of this project, it was determined that many net-centric concepts that have proven successful in the warfighting domain also provide corollaries in the support processes.

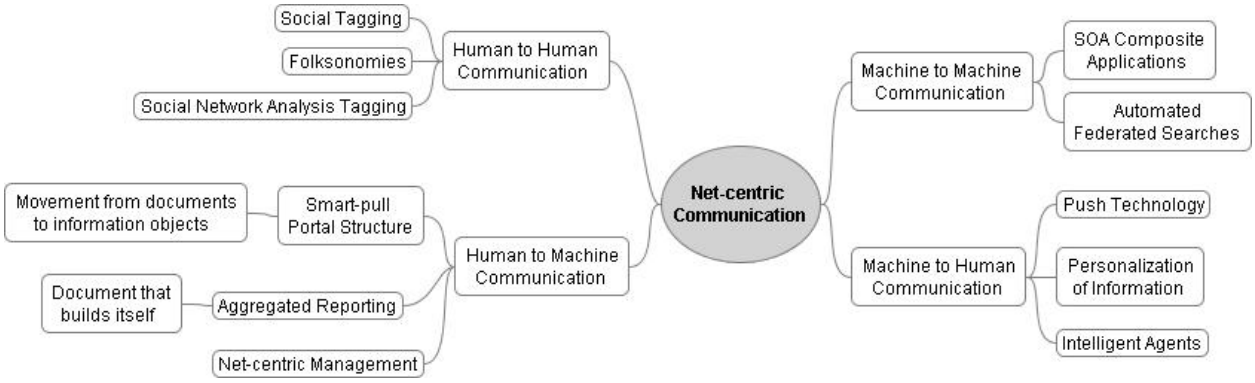

Figure 1: Net-centric Communication

Categories of Communication in a Net-centric Environment

The net-centric environment is an environment that involves both applications (or more broadly, machines) and people, interacting in a myriad of non-linear ways. The environment is multi-headed, with each COCOM potentially requiring a different set of tools and support processes for a different Operations Tempo. In fundamentally examining the different types of communication occurring, we can decompose them into the following four categories depicted in Figure 1:

- *Machine to Machine*: Machine to machine communication involves communication initiated by one application or device to another application or device, in which there are clear rules for interaction that can be initiated without human intervention. An example would be within the AEGIS weapon system, where the phased array radar communicates with the fire control system to automatically launch a response to an attack if certain conditions are met. A more complex example might involve an ensemble of service-oriented architecture (SOA) enabled applications that, based on

an event-based trigger, automatically send messages to other SOA applications. Industry is using this approach to build business process management (BPM) applications. Machine to machine communication requires clear data exchange standards and tagged knowledge artifacts. In net-centric terms, the data must be visible, accessible and understandable within a trusted environment for machine to machine communication to take place. Because the underpinnings of machine to machine communication are already being explored in extensive detail elsewhere, they will not be explored in this paper.

- *Machine to Human*: Machine to human communication involves communications initiated by applications or devices for human consumption. Examples include intelligent agents, which, based on a predefined set of parameters, periodically query a set of information then provide the results to a person in the form of an email or updated web page. Personalization options also provide examples of machine to person communication within a net-centric environment.

- *Human to Machine*: Human to machine communication currently comprises the bulk of our current interactions within a net-centric environment. In human to machine interaction, warfighters and support personnel are accessing various applications (portals, weapon systems and other devices) to find information critical to their current needs. The application responds to the users requests, and (hopefully) provides them with the needed information. Performing federated searches, using C2 systems such as Global Command and Control System (GCCS), and accessing portals such as Army Knowledge Online (AKO) are all examples of human to machine communication.

- *Human to Human*: Human to human communication in a net-centric environment can be formal or informal, structured or unstructured. It is enabled with various collaboration, communications and information transparency tools, but the fundamental purpose is to allow people within the net-centric environment to connect and share with one another.

This article focuses on the human interface to the net-centric environment. While some elaboration will be devoted to machine to human and human to machine interaction, the bulk of the discussion will center on providing options for improving human to human communication. It is our position that an emphasis on human to human communication could result in substantial benefits that increase overall performance and capability even with very small investments in applications and infrastructure. This emphasis on human to human communication leverages and exploits existing expertise to provide a significantly different approach for finding, accessing and using Departmental knowledge assets. In pursuing human to human communication, this focus necessitates a discussion on work culture transformation, as information sharing will continue to encounter challenges until the Department can move from an information hoarding to an information sharing environment.

Netcentricity is Tooth to Tail

The definition for Net-centricity has been stated a number of times in various venues. In the Net Centric Data Strategy, Net-centricity is defined as:

> *"…the realization of a networked environment (including infrastructure, systems, processes, and people) that enables a completely different approach to warfighting and business operations…Net-centricity, by securely interconnecting people and system s independent of time or location supports a substantially improved military situational awareness, better access to business information, and dramatically shorted decision cycles. Users are empowered to better protect assets; more effectively exploit information; more efficiently use resources; and create extended, collaborative communities to focus on the mission."[1])*

While the criticality of information sharing across C2 systems at the point of attack is unquestioned, numerous reports and studies have validated Moor's Law and the need to decrease the cycle time of the acquisition and capabilities development processes. The goal as described in the Joint Defense Capabilities Study[2] is to get the warfighter the capabilities they need in a timely manner. As we look at the implementation of Net-centricity within the warfighter support organizations, the majority of the effort has been spent on improving the infrastructure and connecting data sources inside emerging communities of interest (COIs). The rationale for this focus is that we need to address the underlying data sharing issues in order to benefit from some of the truly powerful machine to machine-based composite applications that can be developed using a Service Oriented Architecture.

While this focus is critical for the reasons stated, this paper will show that other communication methods also hold significant promise for improving mission capability and performance. An examination of their potential, along with possible initial pilot investments could fill critical capability gaps in a reasonably short time duration. Our big picture view for addressing these concerns is to transform the capabilities development and acquisition processes to operate in a net centric environment, similar to that of the warfighter. In other words, **our** contention is that the capability development and support organizations can be vastly improved when information superiority is viewed as a continuum from tooth to tail.

To develop our thesis we will present some conclusions from our pilot study, examine the net-centric communications categories and touch on methods to measure progress toward a net-centric support environment.

IT RIT Pilot: Experiments With a Net-Centric Environment

In the spring of 2001, senior leaders of the Department determined that emerging threats, new defense strategies, technological opportunities and the mandates of the Clinger-Cohen Act (CCA) required a fundamental transformation of how DoD acquires and manages its critical IT resources. The transformational goal of the RIT was to "***Reduce the cycle time to deliver mission-effective IT capabilities to 18 months or less and improve the product."*** In support of this goal, the RIT developed 32 recommendations that were briefed and approved by the

Department senior leaders. To develop a plan for transformation, it was determined that some of the recommendations should undergo experimentation within active programs by employing a pilot approach. The principal output of the three year RIT Pilot was a set of findings, that in combination with the RIT recommendations, could be used to develop a "***A Blueprint for IT acquisition that is transferable to the acquisition of other IT systems."*** A detailed report of the RIT Pilot conclusions, governance structure and operations can be found online.[3]

After a three year period of research and experimentation, our conclusion is that if we are to maintain information superiority for the warfighter, the investment community must benefit from net-centricity in the same way as the warfighting community. The thesis of the RIT Pilot Report is that the Department's functional and acquisition business communities can also employ net-centricity to achieve information superiority that in turn can yield unprecedented speed, agility and self-organization for our IT/NSS investment process. This idea of self-organization is analogous to self-synchronization in Network-Centric Warfare (NCW). Self-synchronization in NCW is employed to allow autonomous groups, each operating under the same mission, to rapidly adapt to changing operational circumstances (more on self-organization later).

The development within the acquisition and capabilities development processes of a Net-Centric Investment Environment creates an environment where a transparency in business operations and full adherence to "post-before-process" concepts generates a shared situational awareness to all stakeholders, both in terms of communicating current warfighter needs and in providing immediate access of cost, schedule and performance measures. However, to achieve such an environment, the RIT Report concluded that:

- Oversight and governance should be transformed and decentralized to allow flexible operations.
- Risk management should become institutionalized and integrated into an evolutionary acquisition framework, with smaller, more targeted development increments.
- Policies should be continually re-evaluated to ensure that rapid and flexible responses are possible while still adhering to the law.

A net-centric investment environment can be characterized as one that self-organizes to rapidly meet the constantly changing needs of the warfighter. A net centric environment is an environment in which there is immediate access in digital format to the information needed to conduct business. Such an environment requires digital connectivity and collaboration tools, an information-sharing work culture, and the ability to improve overall performance by disseminating best practices and lessons learned to the rest of the workforce. As is clear both from business literature,[4,5] trust is required to transform our current information-hoarding culture to an information-sharing culture similar to the culture of the Net-Centric Investment Environment outlined in the IT RIT Pilot Report. Our current information-hoarding culture is built on mistrust at all levels. The use of program office portals, ubiquitous connectivity and collaboration tools are only effective if the underlying work culture is ready to except this change.

Self-Synchronization for Warfighters

Alberts et al. refer to self-synchronization as one example of highly decentralized C2, in which lower-level decision makers are guided only by their training, understanding of the commander's intent, and their awareness of the situation in relevant portions of the battlespace.[6] In this section we endeavor to make the case that self-synchronization is analogous to what the business community calls self-organization. Self-synchronization puts forward an answer to the essential asymmetry of modern warfare that size is no longer proportional to power. In combat, each individual soldier or small unit is empowered to autonomously understand, locate and destroy targeted threats. Empowering decentralized action with precision, synchronization and agility is the goal of Net-centric warfare. Specifically, NCW states:

> *"Self-synchronization is a mode of interaction between…two or more robustly networked entities, shared awareness, a rule set, and a value-adding interaction. The combination of a rule set and shared awareness enables the entities to operate in the absence of traditional hierarchical mechanisms for command and control. The rule set describes the desired outcome in various operational situations. Shared awareness provides a mechanism for communicating the ongoing dynamics of the operational situation and triggering the desired value-adding interaction."*[7]

Alberts and Hayes, writing in "Power to the Edge,"[8] state the assumptions for self-synchronization that ensure that the results will not be chaos in the battlespace:

- Clear and consistent understanding of command intent
- High quality information and shared situational awareness
- Competence at all levels of the force
- Trust in the information, subordinates, superiors, peers, and equipment

In a recent interview, Garstka, one of the authors of Network Centric Warfare (NCW), stated that Operation Iraqi Freedom demonstrated the power and precision of NCW:

> *"Almost every aspect of network-centric operations described in the book came to pass in some capacity during Operation Iraqi Freedom. These included improved information sharing, common operational and tactical pictures, enhanced shared situational awareness, and increased speed of command and self-synchronization—with the net result being increased mission effectiveness."*[9]

With this background we are prepared to argue that self-synchronization, as achieved in Network Centric Warfare, has a corollary in the business world: it is called self-organization.

Self-Organization for Business

Self-organization embraces the notion of developing "virtual" organizations to handle the complexity presented in a knowledge work situation. Self-organization is a key attribute of today's professional teams and communities. The leadership of IBM Global Services found that self-organization has a number of enablers,[10] including:

- Leadership proactively supports a value system that encourages sharing behavior
- Leadership provides incentives to reinforce the value of sharing
- A strong alignment with strategic goals
- Best of class processes for management of intellectual capital
- Balance and linkage between formal and informal organizations
- Organizations are open systems for flow of data and information
- Enterprise-wide technology for effective knowledge management.

To gain insight into the consequences of not providing the enablers of the IBM Global Services experience, or the Alberts and Hayes assumptions presented earlier in this section, we turn to Paul Bracken, writing in the Autumn 2002 edition of Joint Forces Quarterly. His view is that without these assumptions and enablers, not only does self-organization not happen, the result can be disorganization:

> *"Self-organization, while it occasionally takes place, is hardly automatic. What often occurs is self disorganization as each division sub-optimizes to manage the complexities that confront it. Enron, for example, was once a natural gas company that transformed itself within five years into an essentially unregulated investment bank that made money from trading futures contracts on oil, gas, electricity, broadband, and other commodities. It raised money to build these trading systems by selling gas fields in Texas and power plants in South America. Moreover, it borrowed heavily to leverage its trading positions. Enron did not have to keep a minimum capital base as did its real competitors, the Wall Street investment banks. Because it was not regulated like a bank, it could transform hard assets such as gas pipe lines into soft ones - bits and trading positions. Enron carried this practice farther than any other company."*[11]

Self-organization concepts have been entering the acquisition process since 2001, when a change in DoD 5000 series documents transformed the acquisition regulations to allow the program manager more freedom to manage toward program goals. This change in the DoD 5000 series documents was designed to move the implementation of the acquisition regulations from a prescriptive model to one that fostered efficiency, creativity and innovation. Specifically, the goals of the change included the following:

- Encourage innovation and flexibility
- Permit greater judgment in the employment of acquisition principles
- Focus on outcomes instead of process
- Empower program manager to use the acquisition system as a tool rather than a burden.

This goal for more innovation was accompanied by increased emphasis in three areas:

- Spiral development, where the desired end-state requirements are not known
- Evolutionary acquisition (using a time-phased requirements approach), and
- Better integration of the requirements and acquisition processes.

All of these initiatives are driving the acquisition process toward a self-organization model – one which readily adapts to the changing needs of the environment and warfighter in order to deliver critical capability as rapidly as possible.

Net-centricity provides significant opportunities for improving the adoption of self-organization concepts to the DoD acquisition of IT. In fact, it allows us to think in terms of a net-centric acquisition environment in which self-organization is the key to meeting warfighter needs quickly and reliably. Net-centric acquisition involves application of net centric tenets in a self-organizing manner to ensure optimal support to the warfighter, similar to how self-synchronization provides another alternative to traditional hierarchical mechanisms for command and control. Self-organization in a net-centric acquisition environment allows programs and their stakeholders an alternative method of tailoring the implementation of policies and procedures to optimize speed, quality, and response time to better meet needed capabilities.

Fostering Shared Situational Awareness

As we look to improve performance in the net-centric investment environment, a shared situational awareness among all stakeholders of the warfighter needs and the program's progress provide the platform for self-organization. A key technology enabler for the shared situational awareness is the Department's commitment to net-centricity and its movement to web services. As the Department's net-centric enterprise services are developed and implemented, they will provide the means for the key players, the FCB/Domain program sponsor and acquisition organization headquarters to pull data posted by a subordinate agency and conduct asynchronous insight. Agents operating either on our command or with preset time, event or threshold triggers will accomplish the pull process.

The RIT Pilots experimented heavily with shared situational awareness concepts in a number of ways. By posting all information in transparent portals the RIT Pilots enabled oversight personnel to accept an ongoing insight role in place of the traditional, time-consuming oversight role. Many experimented with the notion of moving away from bundled documents and instead moved toward maintaining the key information sets that feed all the acquisition documents. Additionally, the RIT Pilots formed a community of practice among the program managers. They were able to share lessons learned with one another to improve overall program operations. In some cases, the programs even worked very closely with the requirements and warfighter personnel to change priorities and get needed capability out quicker than would otherwise have been possible. Many of these ideas advanced in the RIT Pilot have already been adopted by the Department. On the business side, the DoD Enterprise Transition Plan (Volume I: Defense Business Transformation Overview), in discussing transformation goals, states that "A key enabler to providing access to reliable management information is the continued migration to a networked information (net-centric) environment."[12]

A Focus on Human Access within the Net-centric environment

The current thrust within NII's implementation of net centricity is a focus on the data strategy. The Net Centric Data Strategy[13] lists the key attributes of this approach, which include:

- Ensuring data are visible, available, and usable when needed and where needed to accelerate decision-making
- "Tagging" of all data (intelligence, non-intelligence, raw, and processed) with metadata to enable discovery of data by users
- Posting of all data to shared spaces to provide access to all users except when limited by security, policy or regulations

Achieving these attributes enables machine-to-machine communication and significantly improves human-to-machine communication. A case can also be made that the net-centric data strategy improves machine to human communication. Additional focus needs to be applied to the human interface portion of the net-centric environment could provide significant and immediate benefits. Both intuitively, and through numerous research examples, we as a Department realize that unless the work culture is transformed, the benefits of net-centricity will not be fully reached. The results of the RIT Pilot effort show that an effort to focus on the net-centric behaviors from a cultural standpoint yields both innovation and process improvements.

Work Culture Transformation – It's All About Trust

Just as operational trust is essential in network centric warfare,[14] both the business literature and DoD senior management support the idea that trust is essential if we are to move from an information-hoarding environment to an information-sharing environment. Ali, Pascoe and Warne, writing in the 2002 CCRTS note that information sharing and subsequent knowledge generation are most successful when interactive environments are cultivated prior to technology based solutions being implemented.[15] Findings from the RIT Pilot Report supports the notion that trust of the source, the organization, and especially the network are all critical factors in moving away from the current reporting processes. Immediate access to information needed to do work, as envisioned by net-centricity, requires cooperative relationships in which each person with a need-to-know has access to another's work without the seeker gaining access via special permissions. In a trusting work relationship, work is done in a transparent work environment[16]. The manager trusts that the information used by the subordinate (which is available to the manager at all times) is the latest and most accurate available. The subordinate trusts that his or her data/information is accepted as authoritative. To get all stakeholders to agree to move toward use of "posted" data, new lines of communication will need to be re-established and fostered among all stakeholders.

Within a net-centric investment environment, the stakeholder roles have the opportunity to work together in a far closer, more comprehensive manner. Macklin, Phillips and Louvieris go even further than this, stating that "people-centered organizational learning and exploitation of knowledge are key to effectiveness in the network environment."[17] Oversight and functional personnel now have the opportunity to become closely integrated with the program office in an insight-coaching mode versus as an after-the-fact oversight role. Instead of intense scrutiny during brief report-out periods on a specific program, oversight personnel now have the opportunity to stay as closely connected to the program as required by the risk-based governance decision. Within a net-centric acquisition environment, programs that are seeking methods to rapidly meet warfighter requirements have a greater need to ensure that all stakeholders become involved in the program office community. Acquisition functionals, like the testing community,

need to stay involved in the program to ensure surprises that might cause significant delays will not crop up at critical junctures.

In conducting the work culture transformation, part of the effort will involves getting the workforce to think differently about the nature of their work. The RIT Pilot Report determined that a net-centric environment provides opportunities for a completely new method of communication amongst stakeholders and integration of the needed information. This, of course, has ramifications on our organizational structures and patterns of communication across the environment. Social relations are essential for conducting business. In the net-centric environment, ubiquitous access to information shouldn't only imply artifacts and knowledge assets, but should also suggest that we can create, access and exploit relationships across the social domain.

Nature of Collaboration in Business

Collaboration in a net-centric environment provides significant opportunities for supporting self-organization and improving performance. In a warfare environment, units are able to collaborate in real-time to self-synchronize in response to changing conditions on the battlefield. Within the net-centric business environment, the same basic processes have to occur. In designing a collaboration infrastructure, it is necessary to consider both its technical and social aspects. While technologies are critical, the design of the network needs to support existing user practices.[18]

Situational awareness is still critical to ensuring proper operational self-synchronization. The difference is that in the business environment, synchronization involves an understanding of the needs of the stakeholders, priority of the mission a list of the available options, and the authority to make changes as required. This ability to self-organize to adapt in a changing business environment is critical to meeting warfighter needs in a timely manner. In moving towards a self-organization approach, there needs to be a recognition that the actual organizational structures and lines of communications may require significant change. The development of self-organizing business organizations that can readily adapt to changing warfighter needs may require a greater degree of flexibility.

Human to Machine Communication:

Human to machine communication within portals comprises the bulk of our current interactions in the net-centric environment. Unfortunately, our current environment is best characterized by the industry term, "Portal Chaos." In the 9 February 2006 edition of Inside the Pentagon, this problem is discussing in relation to accessing intelligence information: "Officers and troops say they sometimes must troll for hours through dozens of classified websites – each unique to a different satellite or aircraft that collects intelligence – to find one piece of data they need to locate and understand a target."[19]

Governance

For effective human to machine communication, governance processes for managing the interaction space is critical[20]. Because of the size and complexity of the workforce involved, governance provides one of the key levers available for ensuring effective performance. There are many aspects which require governance, including:

- *Data standards adherence*: This aspect is already well covered and is not the subject of this paper
- *Interface design standards*: Radically different functionality and look and feel of the myriad of net-centric interfaces places an undue cognitive burden on the workforce. Usability, Interface design standards and styleguides can be adopted at the COI level. High-level policy concerning interfaces to ensure cross-platform usability can best originate at the DoD level. The overall degree of usability across the net-centric environment significantly contributes to whether or not the Department culture will accept and support a net-centric environment.
- *Enforcing Net-centric behaviors*: In moving DoD towards a net-centric environment, it is critical that the net-centric tenets become a normal method of operations. Governance at the DoD level and the component levels should evaluate and recommend changes to ensure these are being adopted in a timely fashion.

Development of a "Smart Pull" Portal Structure

Many of the key lessons learned and recommendations for future improvements within the RIT Pilots dealt with the use of oversight information in a portal. A number of the RIT Pilots were able to work toward ensuring that their programmatic information was transparently available to all who needed access. One problem that plagued the RIT Pilot was the inability to develop a single portal that all stakeholders with a need to know agreed to use. The Services have different needs than oversight and functional personnel in terms of content organization, access and use. Based on the RIT Pilot experience, we have come to the conclusion that it is counterproductive to force all stakeholders to use the same portal to access information. Each stakeholder has different needs and concerns that necessitate a different latency, access and view of the overall acquisition program data set.

A more comprehensive solution within the acquisition process involves having each information owner posting their information in an accessible fashion, which is then pulled into various customized portals that subscribed to their information. The overall architecture must dictate that information owners (in this case, program offices) ensure their data is accessible at all times to those who require access to it. In instances where either Program Executive Office (PEO), functional or oversight personnel develop information, they should also make it accessible to those who require access. This approach provides each stakeholder (or groups of stakeholders) the ability to develop customized "views" of the data required to perform most effectively. The PEO who focuses on a portfolio of programs will have a completely different need than OSD oversight personnel - their "views" should reflect this difference. For instance, OSD Acquisition Oversight personnel could create a view for action officers to review a set of programs; this view may be significantly different from a functional or PEO view. The program's information

becomes the authoritative source which everyone else accesses, but they do so in a way that is tailored for their individual needs

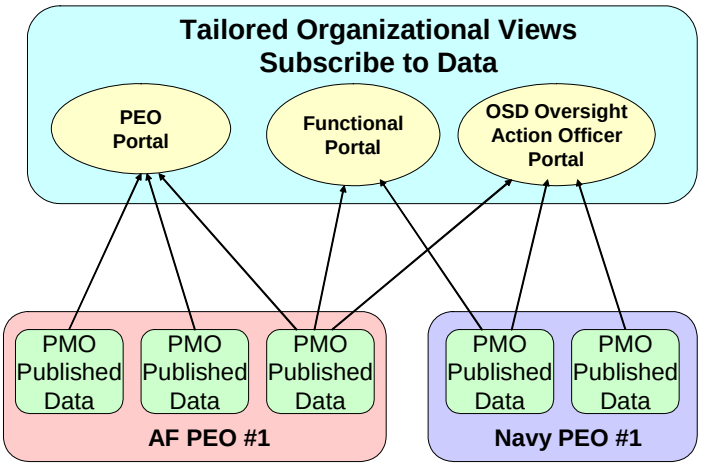

Figure 2: Tailored Organizational Views

Movement from Documents to Information Objects

Part of a movement toward self-organization within the acquisition process involves posting information in a way that others can use for their own needs and purposes. RIT Pilot Programs attempting to move toward a more net-centric method of storing information complained that they were often updating the same piece of information into multiple documents. At the same time, the RIT Pilot Team conceded that oversight personnel have not stated the individual information elements they need to operate in the TO-BE net-centric environment. Instead, most oversight personnel, when asked what they need to do their job in a TO-BE world, they stated that they needed the same documents they received today.

Problems arose as the RIT pilots and their oversight organizations transitioned between a hard copy document-driven environment and the simulated net-centric "transparent portal." The simulated environment did not have the to-be agent driven notification of changes warranting an Action Officer's attention. Consequently, normal (AS-IS) coordination and staffing procedures for acquisition documents were not followed and led to confusion and delays.

One solution is to have the program offices produce accessible information objects or information "chunks" instead of documents. These information objects could be subscribed to, meaning others could access these objects whenever needed, and be automatically updated when these objects are changed. When combined with the development of automated document templates for standard acquisition documents, this allows, the program office, the PEOs and OSD to construct the required acquisition documents out of the information objects. For instance, if the program office has a watch list of key risks, this can automatically be added to a Test and Evaluation Master Plan (TEMP) or System Engineering Plan (SEP). Whenever the document is requested, the current version of each requested object could be dynamically inserted. In the example shown in Figure 3, core information from the program is extracted into document templates. For instance, a TEMP document template can be developed that pulls together all necessary document information. This allows the program to keep the information required to build the TEMP (including the risk assessment, acquisition strategy, various test

plans, etc.) as separate and distinct information objects that are continuously updated. At the same time, a TEMP document that combines all required objects could be constructed whenever required.

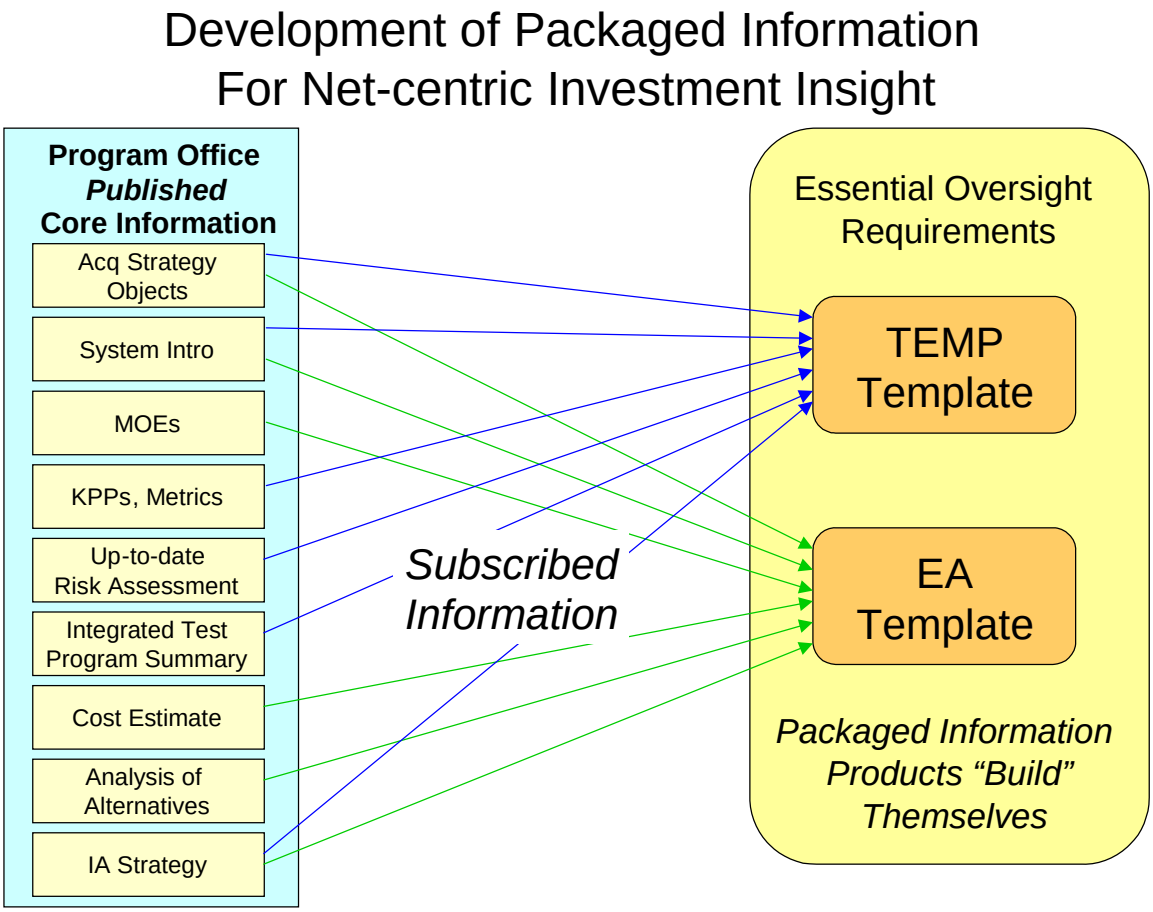

Figure 3: Development of Packaged Information for Net-centric Insight

Similarly, laborious, overlapping documents like the OMB Exhibit 300, the Clinger-Cohen Act (CCA) certification requirements can be automated in the same fashion. This allows the programs to focus their energy on clear thinking, not deadlines for document development. At the same time, this provides instant transparency to OSD, who can take this information and automatically have it accessible to their action officers responsible for reviewing the programs.

In the spirit of maintaining trust, the analysis reports OSD sends to Congress, OMB and the GAO, would be available to PEOs and program offices by subscription. In a net-centric acquisition environment, all information would be made accessible to those who need it.

The Report That Builds Itself

In a net-centric acquisition environment in which programs have transitioned to a "Post before process" model, the use of smart pulls can change the nature of the reporting processes.

Currently, reporting is a laborious and time-consuming exercise in which each echelon has to combine, consolidate, and sanitize information prior to sending it "up the line." "Post before process" ensures that program documentation is already accessible. Instead of adhering to hierarchical reporting structures, the reporting processes can be revised significantly to allow a smart pull of the information that is already accessible. By providing direct access to the data in an accessible fashion, a significant amount of time and effort can be saved in developing original, fully-structured reports to send up the line. Instead of reporting processes such as milestone reviews being a "point-in-time" event, the information from the reports can be instantly accessible at all times. Significant reductions in acquisition development time are available by making such changes in the reporting processes, as a lot of time normally devoted to preparation for critical reviews can be devoted towards development. We recognize that even though information would be accessible, there would still need to be an agreed-upon rhythm for the program to post various pieces of information and documents.

Support for Net-centric Management

With OSD focusing their personnel resources on investment decisions for meeting capabilities at the portfolio level, the Component Headquarters and PEO staff will need to expand their ability to conduct individual program oversight functions. This is imperative and needs to be implemented in such a way that the program offices can simply work their programs, while at the same time, the PEO is able to both gather and correlate key pieces of information from each program to make decisions at the PEO portfolio level. In the example shown in Figure 4, the AF PEO C2&CS develops portfolio views of their overall risk profile, overall portfolio metrics, and overall capability delivery schedule.

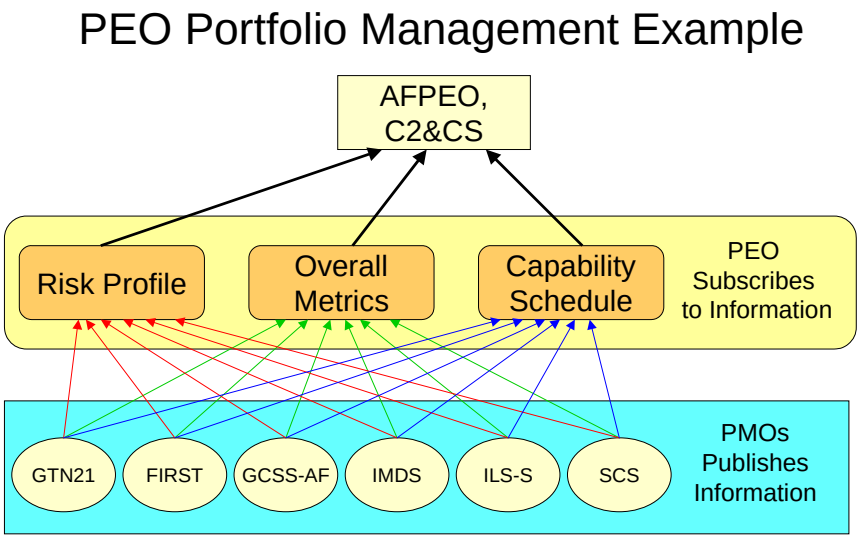

Figure 4: PEO Portfolio Management Example

In summary, today's extensive human-to-machine communications needs of the diverse internal and external stakeholders within the DoD investment process can be significantly improved by adopting the communications opportunities presented by a net-centric investment environment.

Machine to Human Communication

Machine to human communication already has a considerable amount of research devoted to it, so little time will be spent discussing it here. There are however a number of technologies which merit mention, including:

- **Push Technologies**: Push technology is an internet-based content delivery system where information is delivered from a central server to a client computer based upon a predefined set of request parameters outlined by the client computer. A number of efforts are under way to utilize Push technologies to get critical information to people in a timely manner.
- **Personalization**: Personalization involves the adaptation of the output of a particular system to meet the specific needs of a particular user. Various rule-based and collaborative filtering approaches are possible to provide more pertinent data to the user.
- **Intelligent Agents**: Intelligent agents are software programs that exhibit some rudimentary form of artificial intelligence (involving the ability to adapt and learn over time), and are usually developed to provide user-assistance in data mining efforts.

Challenges to machine to human interaction are similar to traditional challenges to human to machine communication and machine to machine communication. Chief amongst them being the need for a single sign-on authorization. As with other machine to machine interaction, intelligent agents provide additional concerns, specifically allowing machine-based services to query the GIG and return results.

Human to Human Communication

Research shows that connections between the key pieces of information in a particular knowledge domain are often best captured by the members themselves[21]. One method to accomplish this is to develop detailed taxonomies that all community members adhere to when tagging their information resources. These approaches to organizing the knowledge domain are geared towards the way people naturally engage in sensemaking, the holistic view of the purpose and expectations of the activities in their world. Regardless, the structuring of the net-centric environment for information sharing purposes should be optimized for each type of interaction.

The knowledge management community has come to the conclusion that knowledge is a product of information both in people's heads and in information repositories.[22] The repositories store knowledge artifacts that relate to a particular decision or product, and which may have a time sensitive dimension. The knowledge in people's heads involves the contextualized capacity to engage in sensemaking with the operational environment in real-time. Additionally, the contextualized aspect of knowledge involves a collaborative dimension in that a knowledge

domain is a product of ongoing discussions and interaction within the surrounding community of practice.[23] In looking at the development of an expanded net centric environment, one that goes from the tooth to tail, it becomes critical that the capability for self-synchronization takes on all possible avenues for sensemaking. To do this, we need methods to access and exploit the knowledge resources resident in the interactions amongst the workforce. This involves the connections between the various information artifacts and the methods by which people interacting with them and understand their utility.

Human to Human Knowledge Sharing – Social Software technologies

Another method for facilitating sensemaking is to provide ways for the users of the knowledge domain to structure the information in the knowledge domain based on the way it is used. Net-centricity advocates the requirement for ubiquitous access to all information. The underlying thought supporting this is that the information seeker might not know what is required, so if everything is accessible, the information seeker will always have access to the necessary information. Unfortunately, this runs in opposition to findings that show that as the amount of information available increases, the quality of the search result set decreases.[24] The problem comes about when we attempt to separate the ocean of data from the critical piece of information necessary at that point in time. While solvable, this is not an easy problem, and only gets worse when more data is included. Currently, the emphasis for finding information in a net centric environment has been to develop metadata to be sent to comprehensive search technologies. However, problems with search technologies will still exist even if we meta-tag everything. The problem in a nutshell is attempting to figure out what piece of information or information sets the seeker needs at any one particular time. As the number of potential documents increase, the potential for error increases and the possibility for useful search results decrease.

Gauvin et. al concludes that within the DoD, knowledge creation most often occurs in social and collaborative settings.[25] Specifically, their research concludes that interacting with others impacts significantly on knowledge creation. One option for alleviating this problem is to strengthen and make visible the interactions and relationships that our workforce uses to conduct work. This approach can be found in the movement towards managing knowledge domain information using social software technologies. Information sharing implies machine to machine, meaning information that exists in a data store. Knowledge sharing implies a more contextual type of sharing that may involve people. Social software is an emerging class of software that enables people to rendezvous, connect or collaborate through computer-mediated communication and to form online communities. The options for applying social software are vast. One option recently presented by Burth discusses the possibility of using “ebay style” market mechanisms as a method of sharing of intelligence information.[26] Often, the relationships and interaction within a social software environment are made explicit both to aid in community formation and to develop a self-organizing knowledge domains structure called a folksonomy (see below).

Our position is that social software could become a near-term force multiplier for the net-centric environment. The various options for social software allow users to structure their knowledge environment in a way that requires very little management attention, while at the same time

targeting the key knowledge assets used by the workforce. This ground-up approach to structuring the knowledge environment has made significant inroads in industry, and could instrumental in improving information sharing, assisting with sensemaking, increasing situational awareness and supporting the transformation of a the work culture. While most are familiar with instant messaging, there are other options that should also be considered. Three options for social software discussed below are social tagging, folksonomies and the use of embedded social network analysis for the development of ad-hoc COIs.

Social Tagging in a Net-centric Environment

In seeking methods to increase information sharing through the strengthening of social awareness, one option is to allow the net-centric information seekers to help in structuring key knowledge assets on the GIG through the use of social tagging. Social tagging is a recent social software technology that has provided significant benefits for accessing unstructured information, and involves gathering enough redundant metadata from the user base that it becomes possible to identify and exploit patterns of use and interaction among groups of users. A hierarchy of related terms is replaced with non-hierarchical, user-generated key words. Using this technology, the user base is able to attach free-form tags primarily for their own use to organize and retrieve their information. However, these tags are shared with the larger community of users. As the user-base grows, the selected tagset becomes stable, and a self-organized knowledge domain emerges. Within a secure environment on a trusted network, social tagging of the knowledge assets within and across COIs would provide a rapid and powerful method of creating relationships amongst the relevant sites and content chunks. The social tagging provides a contextualized set of query results. In developing the social tag structure, the users end up creating the critical relationships among different types of knowledge.

Social Tagging is primarily about sensemaking (structure of collaborative tagging systems). The tags that are generally the most meaningful will likely be used by many "taggers." Tags with personal or specialized meaning will likely be used by fewer users. Research on the use of *Del.icio.us*, a popular social bookmarking tag site, shows that stability in tagset emerges after fewer than 100 bookmarks.[27] Given enough users and enough tagged artifacts, a consistent and preferred set of related tags will emerge as a by-product of the social interaction. Most tagging is done for personal use rather than public benefit, but information tagged for personal use yields public benefit. Each person's tags are made accessible to the rest of the community, and thus, can be aggregated to provide options for understanding the overall knowledge collection. "The stability we have shown here demonstrates that tagged bookmarks may be valuable in aggregate as well as individually, in performing this larger function (sensemaking) across the web."[28]

Gauvin et al observe that "communities of practice informally exist in the military setting, but they are not structured in a way that the organization can efficiently leverage them and support them by technological means."[29] Social tagging provides one mechanism for supporting, enhancing and exploiting communities within the Department by technical means. Various clustering technologies can be applied to the tagsets employed that allow a user to see relationships among critical pieces of content as defined by its users. More important, as this process is organic, the benefits are immediate, and the organization and management attention required is minimal. In short, social tagging allows the user-base to organically structure the key

pieces of information in their knowledge environment, and the knowledge domain structure that "emerges" provides rapid and significant benefits to overall sensemaking and situational awareness.

Folksonomies in a Net-centric Environment

Along with social tagging, social software has engendered a shift from the use of complex, rigorous taxonomies for organizing the knowledge environment towards simple, organic, socially driven knowledge assets. High quality taxonomy development is a complex and laborious process that has a number of problems, including:

- Difficulty gaining agreement on the structure
- Documents are usually viewed in terms of various facets, not though single perspectives
- Over time, the information structure needs to change.
- The larger the taxonomy the more difficult it is to comprehend[30]
- Taxonomies are resource intensive
- Benefits are only realized after a detailed investment of time and money
- Taxonomies are context-independent[31]

In viewing the net-centric investment environment in self-organization terms, the detailed taxonomies that take a long time to create, may also require substantial revision over time. While taxonomy work is critical in developing machine-to-machine interfaces, a social software option popularly known as folksonomies provides an augmentation to this approach for connecting unstructured data in the human to human communications environment:.

Folksonomy is a term for a social ontology that is a user-generated classification, emerging through bottom-up consensus. The most recognized folksonomy in use is the Wikipedia (http://www.wikipedia.org). The folksonomy approach addresses a number of concerns in taxonomies. One key goal of comprehensive taxonomy development is to enable "faceted classification." Faceted classification is a non-hierarchical matrix-based structure, consisting of multiple tree taxonomies used together. Instead of having to create multiple, clear taxonomies to represent the various "facets" of information required, the folksonomy approach, which has no inherent hierarchy, creates a multi-faceted information environment, that changes as the tag set pattern usage changes in the workforce. Folksonomies offer additional benefits, including:

- Folksonomies provide immediate benefits to users, which leads to immediate benefits to the organization; whereas taxonomies only return value after a detailed set is developed
- As folksonomies are organized and maintained by the users, there is little overhead maintenance required after they are up and running
- The cost of developing the taxonomy is significantly reduced
- Significantly less training is required to get users to understand the structure
- Folksonomies derive a social network from a symantic one
- Trends of information use emerge[32]

Supporting Ad-hoc COIs With Embedded Social Networking Data

Ad-hoc Communities of Interest (COIs) as an idea has garnered a lot of enthusiasm, yet there has been relatively little specificity on implementation provided in the Department's Net-Centric documentation. The intent is that to effectively meet new and previously unforeseen "challenges," ad hoc COIs would allow the workforce to rapidly respond and self-organize to address the challenges. Through discovery services, the knowledge assets on the GIG will have metadata that will allow the information consumer to identify and decide whether the information product is useful. In some cases, an information consumer might decide to form a COI with other workforce participants. The question is how to transfer the ideas for Ad-Hoc COIs into an operational approach for implementation. For instance, how does an "ad-hoc" COI get formed? How would the people forming and ad-hoc COI ever figure out who to invite and why would they agree to come and devote resources to it? What would their relationship be to formal COIs? How would organizations work out the resourcing issues involved in having their people working on taskers from the ad-hoc COIs outside their mission area?

The answer lies in applying results from automated social network analysis (SNA) to the GIG Architecture. Social Network Analysis involves understanding the tacit social networks that allow one to gain access to necessary information and to collaborate with the colleagues to actually get things done.[33] Dunkelberger et al[34] have explored this concept in relation to capturing dynamic, real time SNA information to provide cues for both technical and operational optimization. This same idea can be applied towards the meta-tagging our knowledge resources. The COI is formed when someone or some group decides that there is value in establishing a community. For an Ad-hoc COI to form within the SNA construct, there must be automated social software tools in place that provide the workforce the shared situational awareness necessary to give information seekers the connection type information they need to decide if there is expertise available that can help address their needs. Ideally, the net-centric environment can identify and make discoverable, natural "clusters" of users that should or could be collaborating. They may be clustered based on the type of information products they produce or may be clustered in the information they access or the initiatives they work. The necessary element is for the information products or knowledge assets in a net centric environment to have contextual information tied to them; including who is accessing it and for what purpose.

To enable Ad-Hoc COIs to become a normal part of our daily work, at least three key aspects need to be in place:[35]

1. A method to identify potential COI members
2. A method to request participation, and
3. A method for organizations to share resources allocated in a cross-organizational ad-hoc COI.

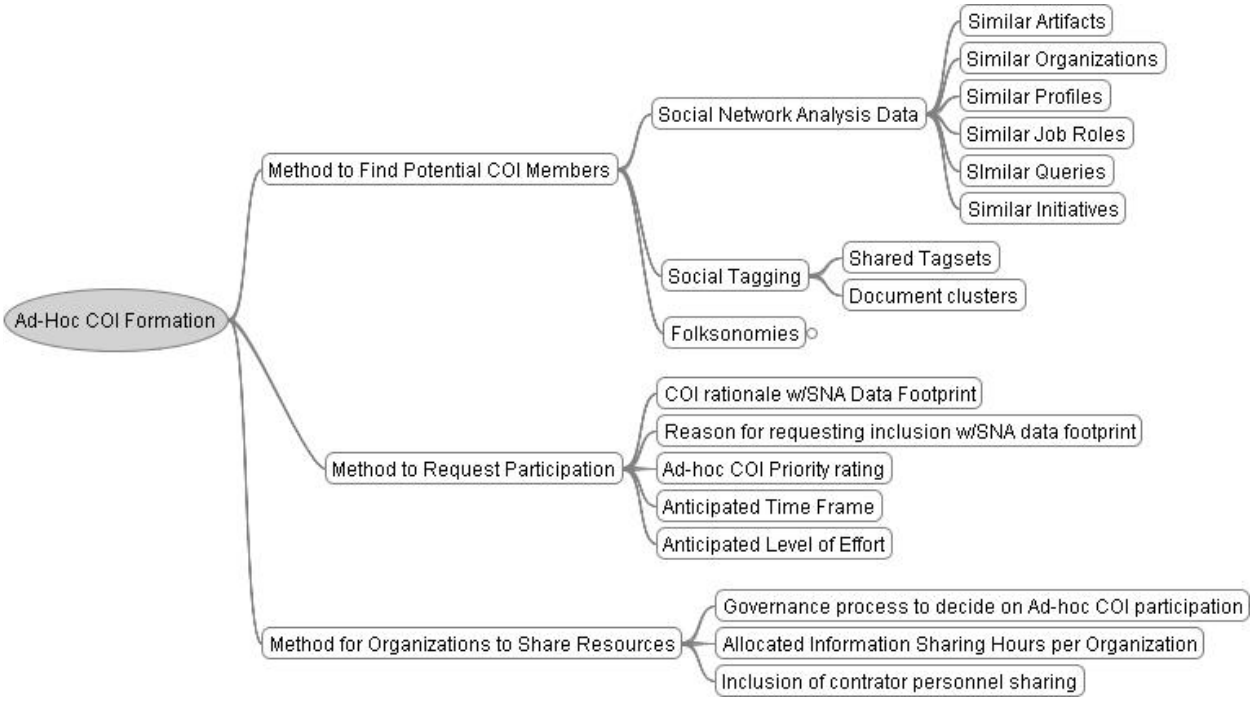

Figure 5: Ad-Hoc COI Initiation

A method to identify potential COI members:
For Ad-hoc COIs to work, there needs to be a method for people from across the breadth of the Department of Defense and related Agencies to "find" each other. The reasons for establishing a COI will be as varied as the time frame for COI persistence. Reasons for wanting to include a person, role, or organization may be due to a number of possible reasons including the knowledge artifacts they have published, the organization's mission, the responsibility of their job role, the types of queries they have been running or initiatives they are working on.

The COI "initiator" or requestor needs to have a method for easily locating these people in the course of the normal work process. One way to do this is to employ "social software" or social network analysis tools tied to information product access and use. In this model, all the "footprints" for knowledge access are captured and shared as security access permits. This means when someone accesses a knowledge asset, they should be able to see:

- The knowledge asset/information product creator
- How often it has been accessed
- The people who have accessed this asset
- The projects and initiatives that have accessed this asset
- Formal relationships with other knowledge assets
- Other knowledge assets accessed by these same people
- Customized taxonomies, ontologies or key user lists that this asset belongs to or is linked within
- Discussions related to the knowledge asset

This level of visibility is critical to the creation of ad-hoc COIs. In effect this allows our knowledge assets on the GIG to become the driver of developing the key information sharing relationships that are the precursor to a collaborative, sharing workforce.

A method to request participation
Once the COI initiator has a sense of who "should" be interested in participating in an ad-hoc COI, there needs to be a standardized method of sending a request for participation; not unlike the process now used for forming an integrated product team. If this is not standardized and agreed upon, existing organizational barriers will serve to minimize any significant ad-hoc collaboration. The request must include a clear rationale for both the COI's existence along with why the requested person should participate. Most importantly the rationale should include a priority rating (critical, major, minor), anticipated time frame (immediate, short term, long term, or undetermined), and anticipated level of effort requested. The rationale should also include an automated report of the social network analysis "footprint" that prompted the initiator to originally request participation.

A method for organizations to share resources
In addition to a request for participation, there also needs to be an agreed upon mechanism for sharing resources across projects and organizations. This might involve each organization maintaining a resource "pool" of hours for ad-hoc COI participation that an organization can charge against. This approach would allow DoD leadership to actually assign a cost and level of effort for the amount of knowledge sharing they are expecting to occur. Most importantly, contract industry participants should also be included in this approach as they may have key expertise that could make the difference, especially in a critical, high priority situation.

From a self-organization perspective, social software technologies allow us to envision ways that ad-hoc COIs can form. By explicitly showing the social usage statistics within and between content repositories, "clusters" of information can be represented.[36] These clusters can be organized by users, groupings of documents or tag sets, accessed folksonomy trees, discussions about problem issues, or groupings of topics.

In connecting people operating in a trusted, secure net-centric environment, social tagging methodologies provide a different level of situational awareness. The social tagging allows the users to understand the ongoing flow of the conversation and problem solving actions that are occurring over time.

Example: Program looking for immature technology solution
If a program has encountered a technical problem related to a technically immature area, the social software enabled net-centric environment would allow them to quickly figure out who was working on similar issues, and what they were accessing. The program's technical lead can be quickly connected with ongoing discussions in a way that allows him or her to determine if someone can help them address the problems they are experiencing.

This is a radically different approach than using a federated search engine to bring back all relevant documents. The search engine will provide an exhaustive list that most likely will not relate to issues occurring that moment. Once the program has a list of documents, they may not be any closer to answering their question. More importantly, if they only have access to a

federated search, the program does not have the capability to fully leverage DoD's expertise on that issue.

Measuring Progress Toward a Net-centric Environment

As in any capability development, it is essential that we have the means for measuring progress towards a net-centric environment. Unless we know how to measure progress, we will not be able to take necessary corrective actions required to ensure success. The Government Accounting Office (GAO) is also interested in this question, as recently they stated, "it is not known how DOD will assess the overall progress of the GIG and determine whether the network as a whole is providing a worthwhile return on investment, particularly in terms of enhancing and even transforming military operations."[37] To measure progress, it is important is to define the net-centric environment in terms of end-state capabilities and their outcome-based performance measures. Once the outcome-based performance measures have been stated, measurement strategies can be applied. Most likely, a combination of qualitative and quantitative measurements will be needed to measure progress towards a net-centric environment.

Our assessment is that there is now a consensus that a culture change from an information hoarding environment to and information sharing environment is necessary for the Department to optimize the benefits from net-centricity. Culture changes are measured through changes in behavior of individuals and organizations. In health care, cultural assessment tools have been developed to assess the degree to which health care systems have embraced a safety culture. In the business world, a number of cultural assessment tools have been developed. There has even been attempts to develop a cultural assessment tool for transforming the Department's work culture to an integrated digital environment[38]. In gauging progress towards a net-centric environment, the Department should consider the development of a net-centric culture change assessment tools, similar to those developed in industry.

Aligning Net-centric Investments with Net-centric Outcomes

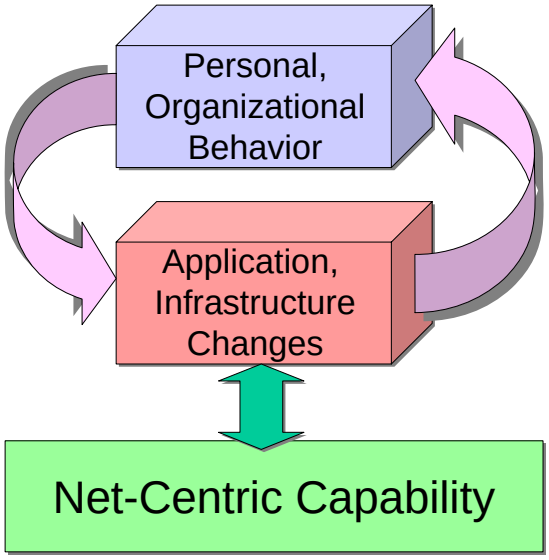

Figure 6: Measuring progress towards a net-centric environment

The Department has invested heavily in the development of a net-centric infrastructure with the clear stated goal that these investments will improve decision times, aid in information sharing and improve overall operations. Post-implementation reviews (PIR) for these net-centric investments will in due course be conducted to determine whether they have in fact achieved their intended outcomes. By including cultural assessment tools in the PIR to gauge whether or not the net-centric behaviors are in place, senior management will able to track progress and make the necessary organizational changes to ensure success.

Conclusion

A focus on the human interface with the net-centric investment environment recognizes that humans themselves are essential to storing, managing and understanding the information, and that sensemaking occurs within the social domain. Information sharing involves both the knowledge and information in repositories, and within and across the workforce. An enhanced focus on supporting human to human communication across the capability and support organizations provides mechanisms to quickly leverage the expertise of the workforce. The human to human communication options presented in this paper are intended to augment the machine to machine data exchange efforts already underway. In short, to accelerate the realization of the Department's net-centric investment, the net-centric environment that leverages both the machine and the human interface should be considered.

Social Software technologies provide a low-cost option for providing a potentially immediate impact towards aiding information seekers in finding critical unstructured knowledge assets. By socially leveraging the expertise of the Department's workforce, both in terms of knowledge and

their relations, the Department will better be able to self-organize within the net-centric investment environment to provide better, faster capability to the warfighter.

If the Department considers expanding the use of human to human communication within a net-centric environment, a good first step would be to develop a rigorous pilot with a target population that has already indicated a desire to increase collaboration and information sharing. If the need and desire for collaboration and information sharing are in place, there are many options for leveraging human to human communication over a net-centric environment that will increase situational awareness, and thereby enable self-organization to take place.

End Notes

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Human Interface to Net Centricity

Presentation for C-154

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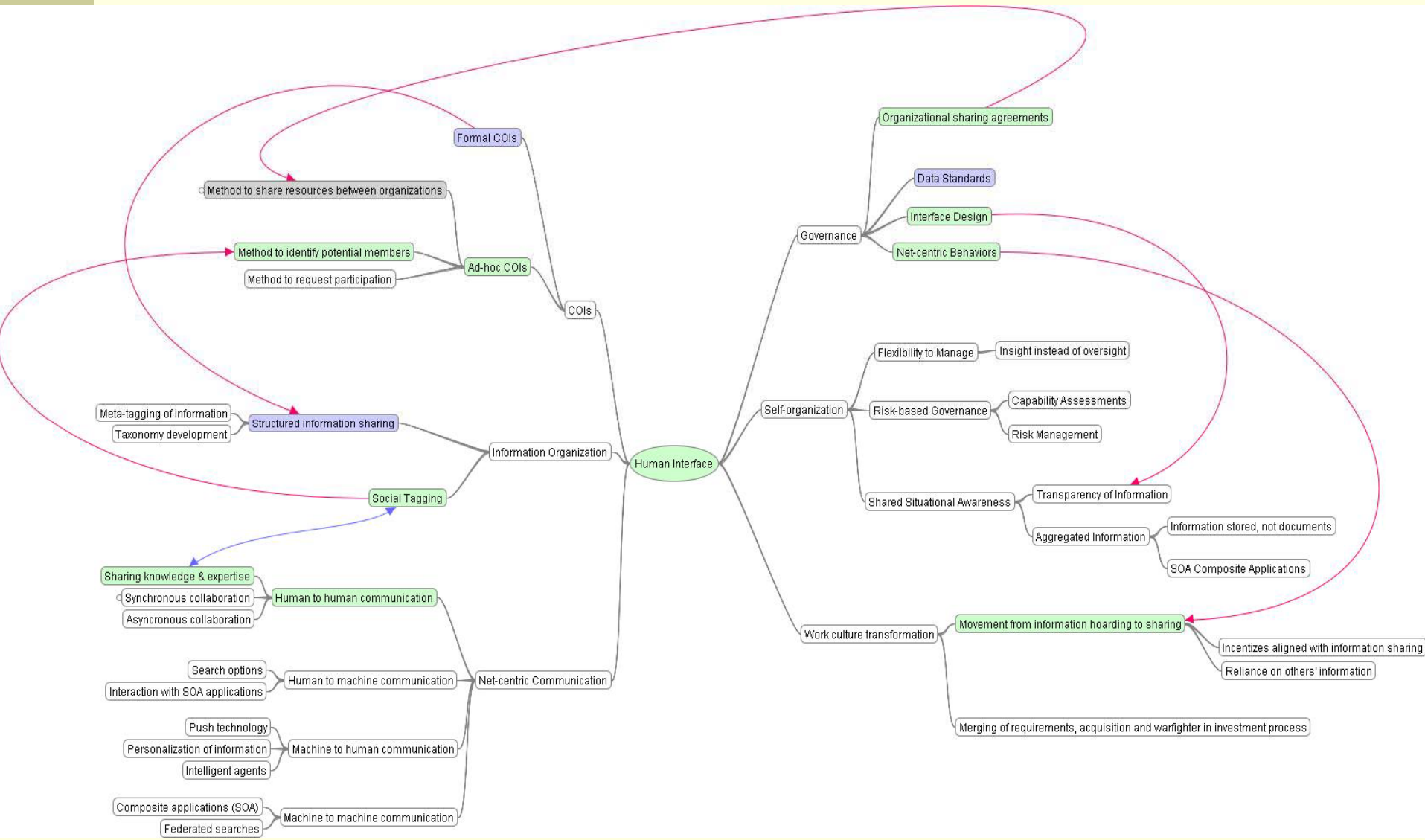
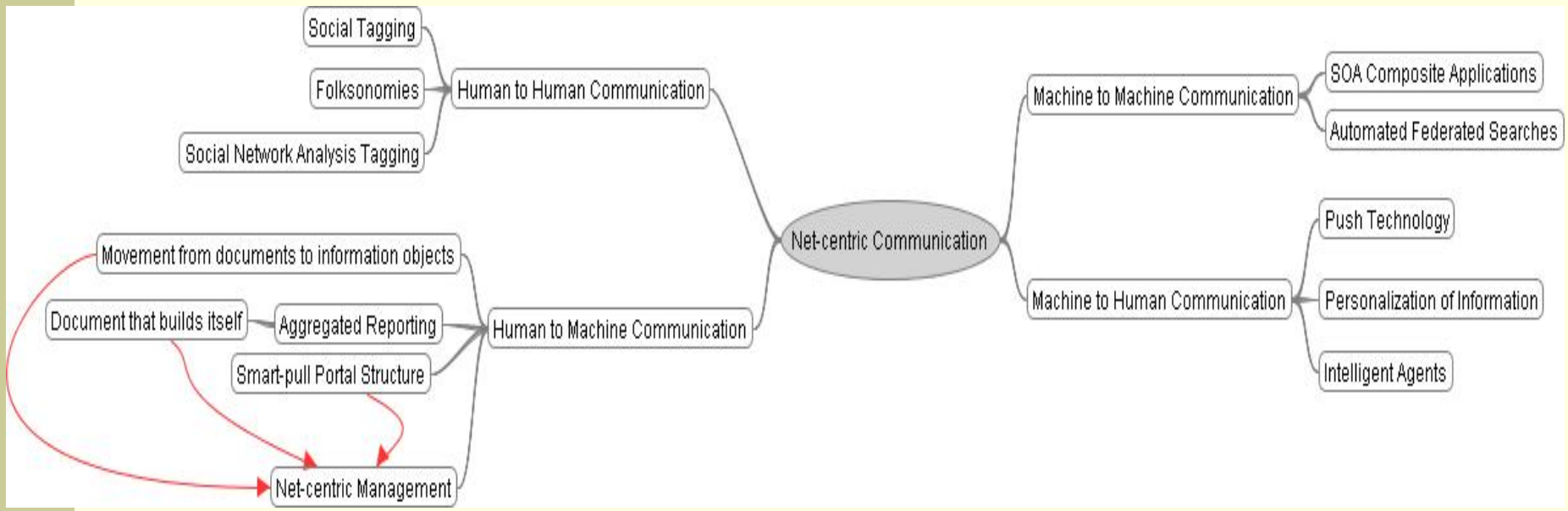
Leonard Sadauskas

Human Interface to Netcentricity



Net-centric Communication



- Human to Human
- Human to Machine
- Machine to Human
- Machine to Machine

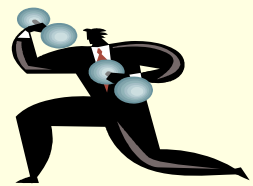
Netcentricity is Tooth to Tail

- Inclusion of the support processes critical
- Goal for net-centric support operations is to close capability gaps
- Netcentricity has the potential to enable dramatic increases in the investment process
- There are organizational implications for transforming the investment process to a net-centric environment

Self-Synchronization in NCW to Self-organization in Business

- **Self-synchronization in NCW**
  - Clear & consistent understanding of command intent
  - High quality information leading to shared situational awareness
  - Competence at all levels
  - Trust in the information, personnel & equipment

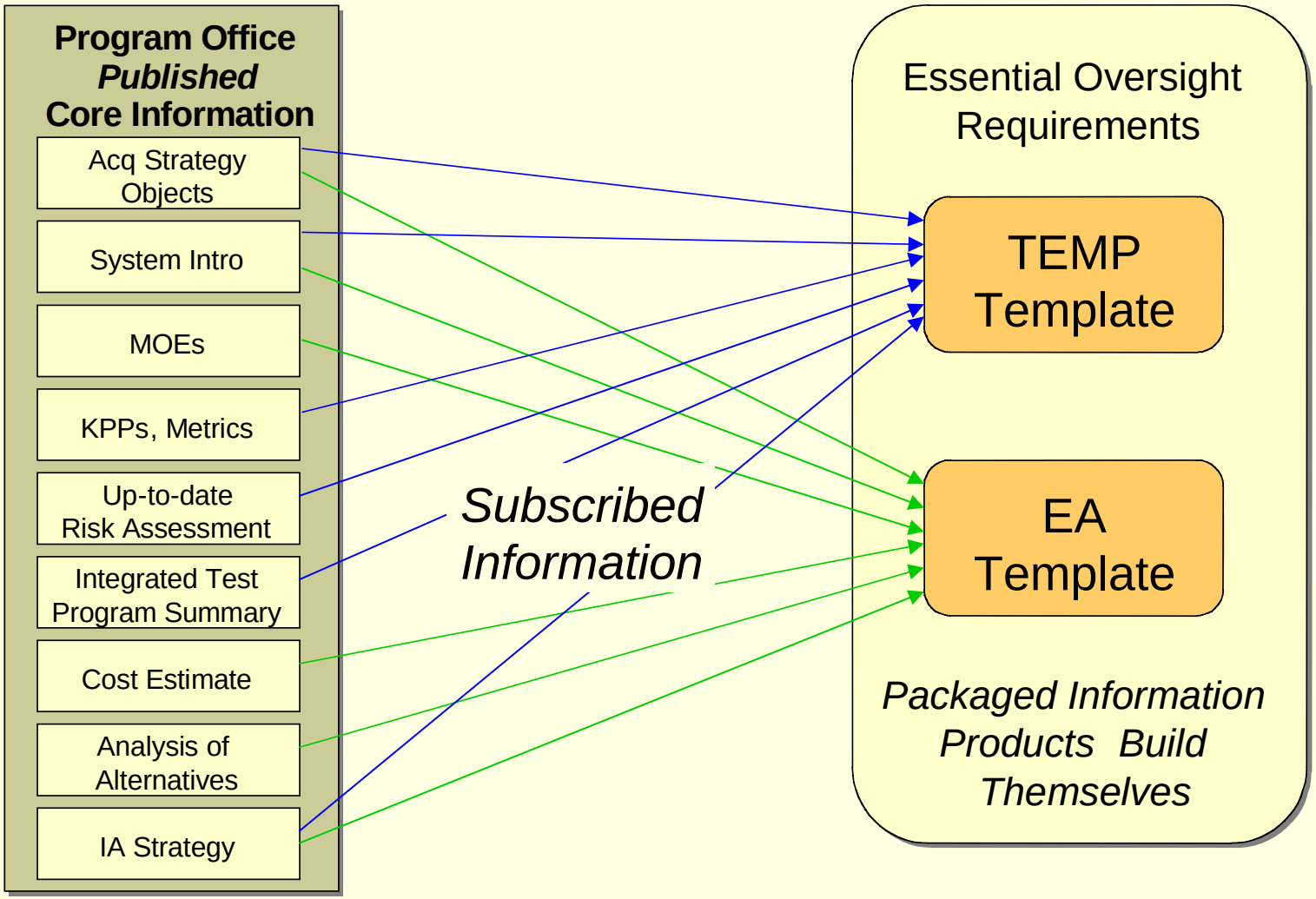
- **Self-organization in the Investment Process**
  - Strong alignment with strategic goals
  - Shared situational awareness by key stakeholders
  - Encourage innovation and flexibility
  - Empower PM to use acquisition system as a tool
  - **Trust** in the network, organization, and personnel



Human-to-Machine Communication Key Concepts for Self-organization

- Governance
  - Data standards
  - Usability, interface design standards
  - Enforcement of net-centric behaviors
- Development of smart-pull portal structures
- Movement from documents to information objects
- Transformation of the reporting processes
- Support for net-centric investment management

Packaged Information for Net-centric Insight



Human-to-Human Communication: Social Software

- Social Software Technologies
  - Bottom-up, emergent sense-making
  - Engages social domain in managing knowledge
  - Assists work culture transformation
- Social Tagging
- Wikis
- Embedded social network analysis data
- Supporting Ad-hoc COI formation

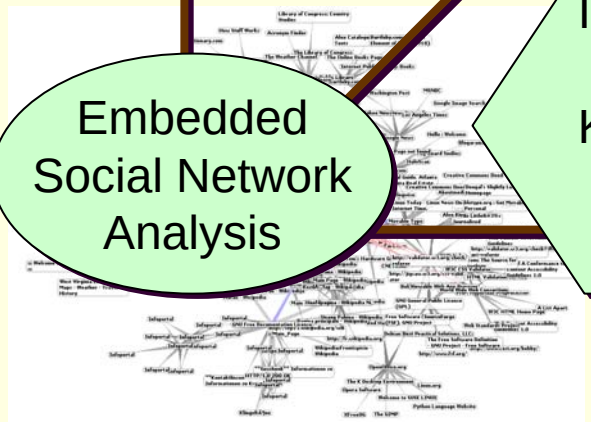
Social Tagging Provides New Options for Knowledge Integration

Software, Relationships Improve With Use

Content Ratings, User Groupings, Mashups

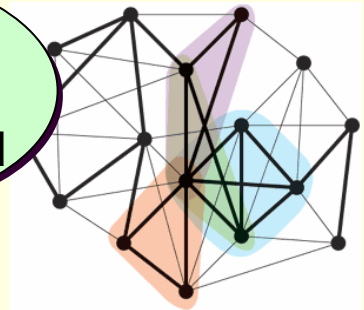
Tags, Folksonomies vice Taxonomies

Embedded Social Network Analysis

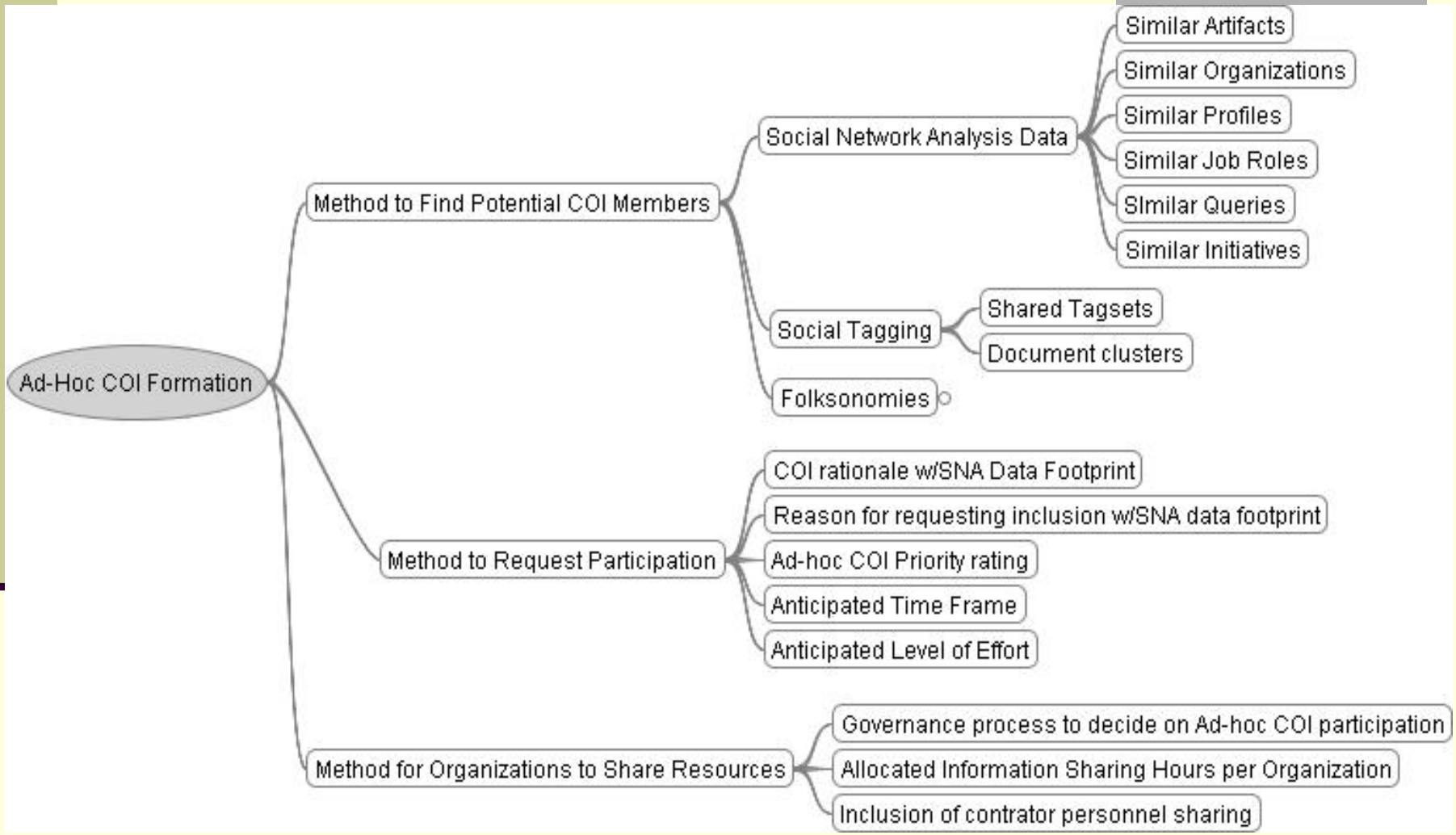


Immediate Impact to Knowledge Access & Sharing

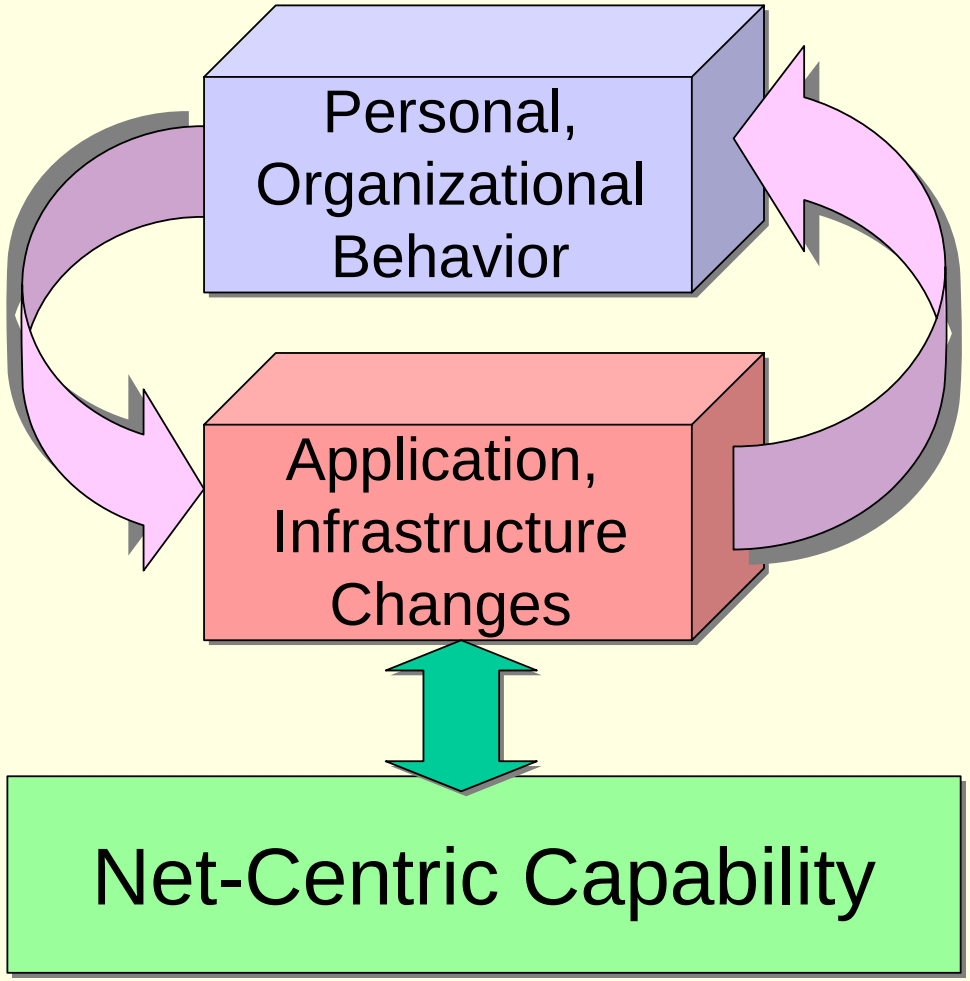
Emergent Behavior not Predetermined



Supporting Ad-hoc COI Formation

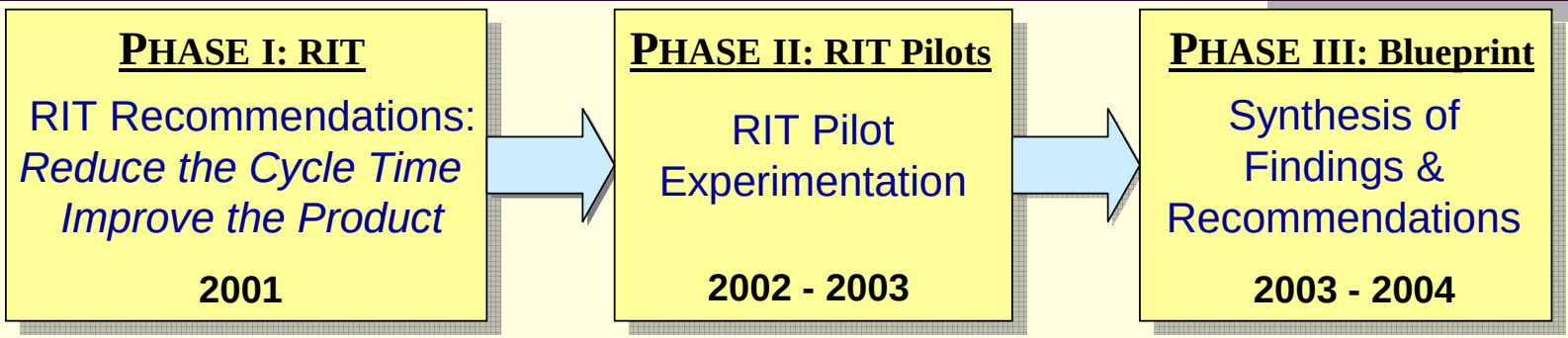


Measuring Progress Toward a Net-centric Environment



Backups

RIT Pilot Project



- **RIT Goal:** Reduce the cycle time to deliver mission-effective IT capabilities to 18 months or less and improve the product

- **Product:** A Blueprint for IT acquisition that is transferable to the acquisition of other IT systems